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Observations of the Planet Jupiter and his Satellites during 1890 *with the* 12*-inch Equatoreal of the Lick Observatory.* By E. E. Barnard, M.A.

During 1890 I paid considerable attention to observations of *Jupiter*. The planet was observed on forty-nine nights with the 12-inch equatoreal.

Careful observations of transits of the principal markings were obtained and a number of filar micrometer measures of the different spots were made.

Special attention was given to a number of small black spots which were distributed around the planet in north latitude about 13°, and which were placed on the northern edge of the great equatorial belt. In all there were six of these singular objects. At the end of August these had about the following longitudes (referred to Marth's System II.) : 41°—104°—213° —258°—327°—352°. They were essentially all on the same parallel of latitude, as shown by the measures of their positions on the disc.

I first saw these spots when observing *Jupiter* on April 26, 1890. They were then quite black and round and about 1″ in diameter, and very much resembled shadows of the satellites. Later, however, they were of a dark reddish colour when best seen. They finally became slightly elongated in the direction of rotation—about 1 : 2. Some of them were intimately associated with a number of very singular reddish spurs or "horse-tails,"

which jutted out from the northern edge of the equatorial belt and streamed following for some 30°. The black spots were on these horse-tails, and seemed to retain their first positions on them with remarkable constancy—the spot and horse-tail having apparently the same rotation period—which was some ten seconds more rapid than that of the Red Spot. A number of measures were made of the distance between one of these spots and the root of one of the horse-tails, but from observations extending over more than a month no trustworthy change was observed. The matter inside the equatorial belt, however, has a very rapid relative motion.

When first seen two of these small spots were directly north of the Red Spot, and separated from each other by about 8″ or 10″. I have numbered this system of spots 1, 2 . . . 6, beginning with the first of the two directly north of the Red Spot.

The spots in the order of my numbering would roughly have the following longitudes on September 1, 1890:

(1) $\lambda = 327°$. (2) $\lambda = 352°$. (3) $\lambda = 41°$.
(4) $\lambda = 104°$. (5) $\lambda = 213°$. (6) $\lambda = 258°$.

I was curious to know if these objects had any relative motion among themselves, and also to see if there was any change of latitude. Spots 1 and 2 offered a fine opportunity to test these points. I therefore selected them for a series of micrometer measures.

The distance between the two was repeatedly measured throughout the opposition of the planet, and their distances from the south and north limbs of *Jupiter* were also determined. These measures were always made when one or the other of the spots was in transit. I do not think that any actual change of latitude, nor any change in the distance between these spots, is shown. There is, perhaps, a very slight and irregular change in the distance, but probably no more than may be accounted for in the measures themselves. In the latitudes a difference of 1° only represents a discrepancy of 0″·3. An equatorial diameter of 38″·7 was used in deducing the latitudes.

These black spots were nearly all of the same size and appearance. Spot 1 was slightly larger than 2, and 5 was the smallest of all.

There were a number of white spots in the southern hemisphere, principally on a parallel just south of the Red Spot. These were small and round, about 1″ to 2″ in diameter, and very much resembled satellites in transit.

I singled out one of these which was south following the Red Spot, and secured some transits of it. This spot was conspicuous and larger than the average, and had a rather rapid motion with reference to the Red Spot. It and another, some 20° or 30° preceding it, were at the ends of the long dark streak or spot

which is shown in Mr. Keeler's drawing in *Monthly Notices*, vol. li. No. 1, close south of the Red Spot. This white spot, at first sharply defined and round, gradually dissipated and became diffused and hazy, and was finally lost through extreme dilution, though it was followed until it had completely passed the Red Spot.

My observations of this and of several other white spots in the southern hemisphere lead me to believe that they make their appearance as bright and clearly-defined spots, and that after an ephemeral existence they finally fade and die out like a melting cloud, to which they are probably analogous.

In reference to the long dark spot south of the Red Spot in Mr. Keeler's drawing, it seemed to undergo a transformation in passing the Red Spot. At first it was merely a portion of the dusky region on which the white spots were located, and was hemmed in between the two bright spots just mentioned. It quite rapidly darkened as it approached the Red Spot, and assumed a definite form—that of a short dark streak, tolerably well defined. I am rather inclined to think that this was not the dark spot to which Mr. Williams called attention (*Monthly Notices*, June 1890), for its appearance near the Red Spot was rather sudden, due to the rapid darkening already mentioned. About the time Mr. Williams speaks of seeing his spot I saw a diffused dusky object following the Red Spot, and bridging the bright space just south of the equatorial belt. This must of necessity have passed over or beneath the Red Spot through its motion; when nearing the great spot, however, it rather rapidly diffused, and finally disappeared. It would be interesting if Mr. Williams could settle this point, since the oblong spot still exists, and retains the same latitude it had when passing the Red Spot, though it is now several hours ahead of the latter object. I have given a few observations of transits of this object in Table III. column 11.

In reference to the Great Red Spot, after passing through several years of extreme faintness, it is again assuming the characteristic appearance of the first few years of its existence. During 1890 it had recovered much of its former distinctness, and at the few observations of this year (1891) it is still more distinct. During 1890 the preceding end was always more difficult to observe than the following end, which was better defined. A light cloud seemed to rest over the middle of the Spot.

Following are some measures of the length and position of the Great Spot:—

1890.			
July 30	Distance of centre from	south limb	$= 14''\cdot5 = 11''\cdot2$ at $\Delta = 5\cdot20$
Oct. 27	,,	,,	south limb $= 11\cdot7 = 10\cdot9$ at $\Delta = 5\cdot20$
Oct. 27	,,	,,	north limb $= 25\cdot3 = 23\cdot5$ at $\Delta = 5\cdot20$

Observations at or close to the time of transit of spot :—

Sept. 14* Length of Red Spot $12''\cdot1 = 10''\cdot0$ at $\Delta = 5\cdot20$

Oct. 27† „ „ $11\cdot4 = 10\cdot6$ at $\Delta = 5\cdot20$

In reference to the discussion that has arisen over the statement that the dark belt south of the Red Spot had overlapped the south part of the Red Spot, I would say that my observations are entirely in accord with Mr. Keeler's beautiful and accurate drawing of *Jupiter* in *Monthly Notices*, vol. li. No. 1.‡

At no time during my observations has any marking on the planet ever overlapped any portion of the Great Spot. In *Publications of the Astronomical Society of the Pacific*, No. 5, p. 91, I have called special attention to this apparent isolation of the Red Spot. It has throughout shown a repulsive force towards the other markings on the planet. At an observation on April 26, 1890, however, the diffused belt south seemed in contact with the south edge of the Red Spot. This perhaps with a small instrument might appear as an overlapping.

Several interesting black transits of the satellites III. and IV. were observed.

1890, August 13. The fourth satellite transited as a black spot, remarkable for its intense blackness. For a full account of this see *Pub. A. S. P.*, No. 10. With first-class seeing and the highest powers the satellite was perfectly round and black.

1890, Sept. 2. The third satellite transited as a black spot. See *Pub. A. S. P.*, No. 11, for a description of this transit.

1890, Sept. 9. The third satellite transited as a black spot. Following are a few notes on this transit.

III. is nearing first contact at transit. It is whiter than any portion of *Jupiter*. Contacts at entrance observed.

Mt. Hamilton M.T. $7^h\ 24^m$ on the disc. Still whiter than any portion of the planet.

$7^h\ 34^m$. Pale now but still distinctly seen.

$7^h\ 37^m$. Just perceptible as a v.v. pale spot.

$7^h\ 41^m$. V.v. faint. There is a *small* dusky speck close following.

$7^h\ 44^m$. It is small and dark.

$7^h\ 49^m$. It is quite dark and very small.

$7^h\ 56^m$. The satellite is black. It is a little smaller than either of the two black spots (1 and 2).

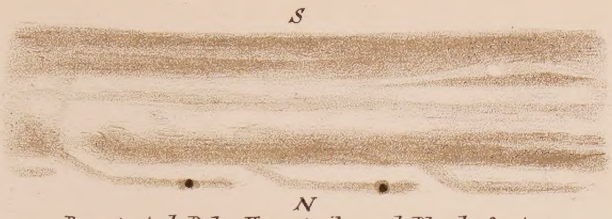
$9^h\ 34^m$. It is still very dark, but it has not been as black as was IV. at the transit of Aug. 13. It is larger and blacker than either of the small spots.

1891, Nov. 27. When three-quarters across the disc the third

* Measured at $7^h\ 17^m$. † Measured at transit of p end.

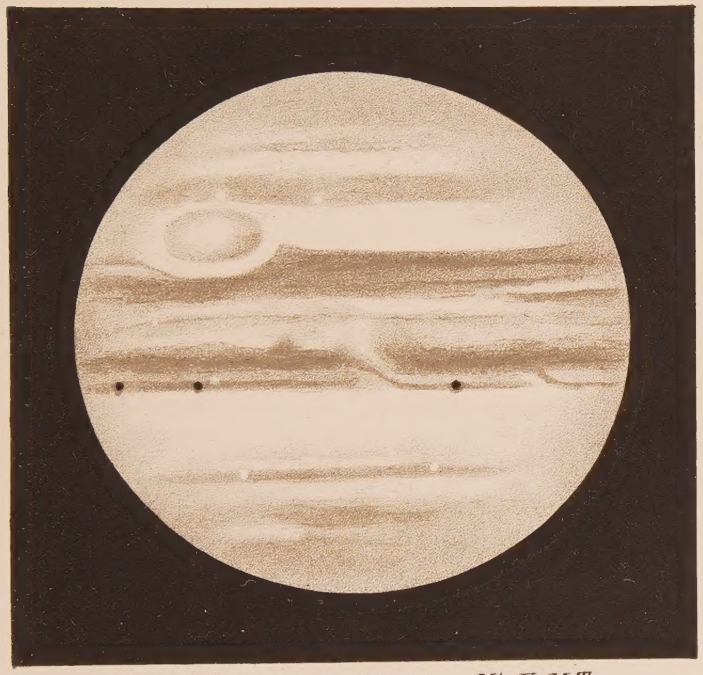
‡ Mr. Keeler's drawings should receive the very highest weight, as he has a real artistic ability such as very few observers possess.

FIG. 2.



Equatorial Belt, Horse tails, and Black Spots. 1890, July 30.

FIG 1.



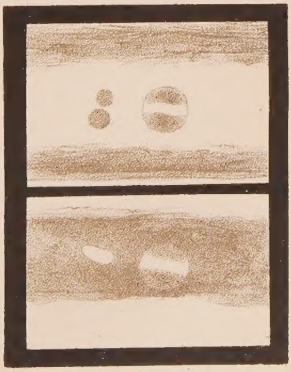
Jupiter, 1890, July 30, 10h. 20m., Mt. H. M. T.

FIG. 3

Satellite IV at egress, 1890 Aug. 13.

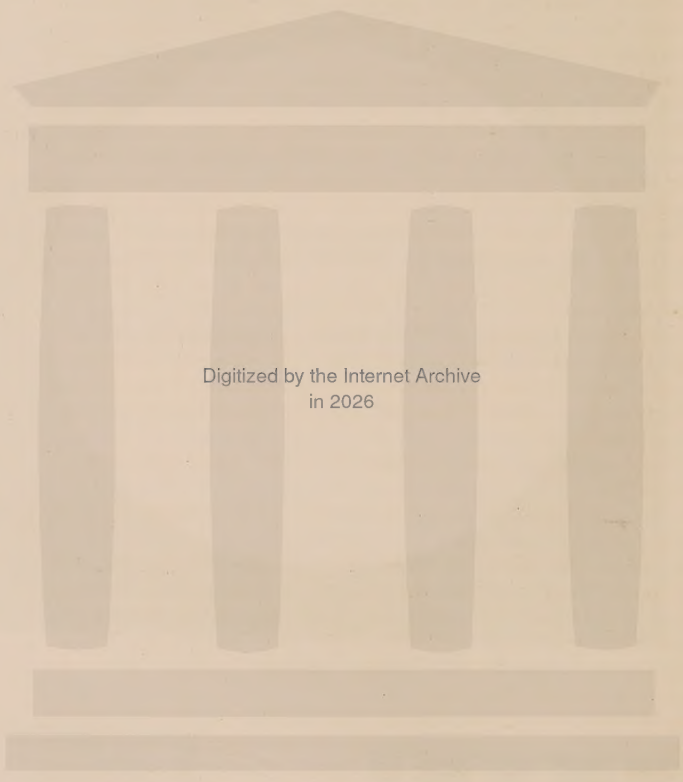
FIG. 4.

Double Transit of Sat. 1 1890 Sept. 8.



Sat. 1, 1890 Sept. 8 & 1891 Aug.

E.E. Barnard, del.



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satellite was very dark. Later, when off the disc, it appeared less than the other satellites.

I send a series of sketches of the appearances of Satellite IV. when emerging from transit 1890, Aug. 13 (Plate 14, fig. 3).

On this occasion as the satellite emerged it seemed to leave behind it a small dark spot which apparently remained stationary and diminished in size, as the satellite receded, until it became lost through exceeding smallness.

In connection with the black transits of III. and IV. I have often seen I. transiting as a dark or dusky spot. On Sept. 8, 1890, with the 12-inch this satellite presented a remarkable aspect while in dark transit. I noticed that it appeared elongated in a direction nearly perpendicular to the belts of *Jupiter*.

With high powers (500 and 700) and perfect definition the satellite appeared distinctly double, the components clearly separated. At my request Mr. Burnham kindly examined the satellite with me, and we both distinctly saw the phenomenon of apparent duplicity (see *Ast. Nach.* 2995). In reference to the *appearance* of the satellite—whatever may be the explanation—Mr. Burnham has no hesitation in stating that it was as distinctly double as any double star that he has seen. The distance between the centres of the two images was about 1″, and the position angle at transit 173°±. The south component was very slightly the smaller (Plate 14, fig. 4). It was not possible to follow the satellite closely, because of interruption by a number of visitors, and the great telescope was not available for observing the phenomenon.

I have offered two explanations of this phenomenon (*A.N.* 2995).

1st. That the satellite had a white belt on it parallel to those of *Jupiter*, or

2nd. That the satellite is actually double. I do not now think that the first of these theories is satisfactory, as it would require a far whiter belt than we have reason to believe will exist on the satellite, reasoning from our knowledge of the phenomena of *Jupiter* itself. I am strongly inclined to favour the theory of actual duplicity.

It may be asked, If the satellite is double why has it not so been seen when projected on the sky, if the distance is as much as one second? In the case of two stars this distance would be very easy with any considerable telescope. We must remember, however, that in the case of a double satellite we should have two sensible discs, which would perhaps never be well enough defined to show a maximum separation of only one second, while the greater part of the time the distance would be much less than this. If, however, the satellite were projected on a background brighter than itself it would appear reduced to its minimum size, so that if duplicity existed the chances for detecting it would be far more favourable. To better illustrate my meaning: Mercury is a very brilliant object to the naked eye about the

times of its greatest elongation. Yet when this planet crosses the Sun it is shorn of its light and cannot be seen with the unaided eye, though it is then a fifth nearer to us. On this same principle if the satellite consists of two moons the largeness of their ill-defined discs would make them appear as one in a telescope. Transferred, however, to a bright surface, the confusing light is got rid of and the size of the object is reduced to a minimum, and if double then will be the most favourable time to detect it.

If this satellite is really double, the components at the time of my observation were probably at their greatest elongation. If so this would indicate a distance from centre to centre of some 2,000 miles. The individual components would be about 1,000 miles in diameter, and their orbits nearly perpendicular to that of *Jupiter*, with a period of revolution of a few hours.

I trust that this satellite at its transits this year will receive the closest attention with powerful telescopes. It should be examined with the highest powers, and the direction of elongation, if any, carefully noted. If double, I have not much hope of the components ever being seen when projected on the sky.

In reference to the abnormal or black transits of the third and fourth satellites, from an experience of many years in actually observing the phenomenon I should feel much hesitation in endorsing the theory that they are due alone to contrast. I have seen these satellites cross the same regions of *Jupiter's* disc in bright transit and again like drops of ink. Assuming the albedo of the satellite to be approximately constant, that of *Jupiter* would need to vary so vastly that it must rank as a variable star.

In speaking upon this matter Mr. John Tebbutt, in *Pub. A. S. P.*, makes a statement that is certainly not upheld by observation. He says, " Further, a dark phase does not take place when the satellite crosses the polar regions of the planet." In *Pub. A. S. P.*, No. 5, pp. 108, 109, I have given a series of observations of the phenomena of *Jupiter* and his satellites, made with a 5-inch refractor at Nashville, Tenn., from which I quote—

" 1880, December 30, $8^h\ 30^m$. Satellite III. seen in a high south latitude as a small black spot; continued visible as a black spot until near p. limb, and only lost its blackness at $9^h\ 4^m$."

" 1886, May 8, $9^h\ 20^m$. Satellite IV. near north pole; very black."

Perhaps there would be no trouble in finding other instances where the satellites have been seen black in the polar regions.

I have never been able, in twelve years' time, to witness the phenomenon of a satellite shining through the limb of *Jupiter*—*i.e.* visible through the planet after the satellite had disappeared behind it in occultation. I have carefully watched a number of occultations with this subject specially in view, but, though the seeing on many of these occasions was perfect, no trace of any

of the satellites could ever be seen after the last contact at occultation. I have, therefore, come to the conclusion that this phenomenon, which has been reported by several observers, is exceedingly rare, or it is wholly beyond the reach of a first-class 5- or 12-inch telescope.

In the drawing of *Jupiter* for July 30, 1890 (Plate 14, fig. 1), I have given a careful delineation of the principal markings. Under favourable circumstances there is always such a vast amount of fine detail shown on the planet with the 12-inch that an accurate representation of it all is quite hopeless. On this drawing are shown three of the small black spots, Nos. 1, 2, and 3. Later in the same night I have given a more detailed drawing (Plate 14, fig. 2) of the equatorial belt and its appendages—the "horse-tails." This also shows spots 3 and 4, and their relation to the "horse-tails."

In the following tables are the observations and measures. They need but very slight explanation.

In Table I. Δ S.P. and Δ N.P. are the apparent distances of the satellites from the south and north limbs of *Jupiter*. "Time for Δ" in the last column gives the time of the measures of the satellites' position.

In Table II. Obs. Δ (I.–II.) is the value by direct measurement of the distance between spots 1 and 2; while 5·20 Δ (I.–II.) is the same quantity reduced to distance 5·20; so also for the quantities Δ N.P. and Δ S.P., which are the values for the distances from the north and south limbs. $\mathcal{U}\beta$ are the Jovicentric latitudes as derived from the measures, and which have been corrected for the elevation of the earth above *Jupiter's* equator by the aid of Mr. Marth's invaluable ephemeris. In the ninth column is given the number of the observed spot.

In Table III. P, M, F are the preceding end, middle, and following end of the Red Spot. Column 11 contains the observation of the oblong dusky spot shown close south of Red Spot in Mr. Keeler's drawing. The white spot in column 12 was at the following end of the dusky spot just mentioned. The measurements of the positions of the small black spots were derived from two to three settings of the wires. Although they were usually very conspicuous, it was found that they were quite ill-defined and rather difficult when the wires were placed over them.

Observations of the Satellites.

Mount Hamilton Mean Time.

Table I.

Date. 1890.	Satellite.	First Cont. h m s	Bisection. h m s	Last Cont. h m s	Mid. Tran. h m	Δ S.P. ″	Δ N.P. ″	Time for Δ. h m
April 26	III. Tr. Egr.	16 3 27	16 6 7	16 8 56				
July 8	I. Tr. Egr.	11 10 4	11 12 1	11 13 9				
30	I. Oc. Imm.	11 22 39	11 24 59	11 26 0				
Aug. 13	IV. Sh. Ing.	10 57 8	10 59 3	11 3 32				
13	IV. Tr. Egr.	...	12 4 30	...	9 42·2	28·4	18·2	10 21
22	III. Oc. Imm.	...	10 45 8	10 48 43				
28	II. Oc. Imm.	9 35 28	9 37 12	9 38 36				
31	I. Oc. Imm.	7 6 39	7 17 54					
Sept. 1	I. Sh. Tr. Egr.	7 25 15	7 26 37	7 28 47				
2	III Sh. Ing.	...	7 7 9	7 11 7				
2	III. Tr. Egr.	7 18 15	7 21 5	7 25 55	...	26·0	19·7	6 52
8	I. Tr.	...	...	...	7 24·7	21·9	22·8	7 33
9	III. Tr. Ing.	7 17 20	7 19 59	7 22 24	9 1·9	25·2	19·4	8 18
Oct. 27	IV. Oct. Imm.	7 15 4	7 18 49	7 21 48				
Nov. 20	III. Sh. Imm.	...	6 52 5	...				
1891. July 4	I. Tr. Egr.	...	13 26 56	...				

July 8.—The times a little uncertain. Aug. 13.—Black transit of IV. Sept. 2.—Black transit of III. Sept. 8.—I. apparently double. Sept. 9—Black transit of III.

Micrometer Measures of the Small Dark Spots.

TABLE II.

	Obs. Δ(I.–II.)	5'·20 Δ(I.–II.)	Obs. Δ S.P.	5'·20 Δ S.P.	Obs. Δ N.P.	5'·20 Δ N.P.	$\mathcal{U}\beta$.	Spot.
1890.	″	″	″	″	″	″	°	
July 30	...	...	29·6	23·2	17·2	13·5	+13·7	1 2
Aug. 1	...	...	29·6	23·2	17·2	13·5	+13·7	1·2
	10·4	8·2	...	...	...	...	...	1·2
11	10·3	8·1	29·2	22·9	16·7	13·1	+13·9	6
13	...	...	28 4	22·4	18·2	14·3	+11·3	1·2
18	9·9	7·8	28·3	22 4	19·0	15·1	+10·3	1·2
25	10·5	8·4	29 6	23·7	17·4	13·9	+13·5	1·2
26	...	...	28·6	22·9	17·5	14·0	+12·5	3
28	9·6	7·7	...	....	...	...	...	1·2
Sept. 5	...	...	29·2	23·8	18·2	14·8	+12·6	4
14	8·2	6·9	...	...	...	...	...	1·2
21	8·6	7·4	27·6	23·7	16·9	14 5	+12·9	1·2
Oct. 12	7·5	6·9	25·3	23·1	15 5	14·1	+12·6	1·2
20	7·4	6·9	24·2	22·5	15·5	14·5	+11·3	1·2
26	...	...	24·1	22·9	14·2	13·5	+13·2	5
27	7·6	7·3	24·2	23·2	14·1	13·5	+13·8	1·2
Nov. 20	7·8	8·0	24·0	24·5	12·9	13·2	+14·6	1·2
1891.								
May 14	8·0	8·2	21·5	22·1	14·2	14·6	+12·2	1·2
July 4	7·4	6·4	25·6	22·1	15·9	13·7	+13·9	1·2

The above measures were made at the time of the objects' central transit.

Mount Hamilton Mean Time of Observed Transits of Spots.

TABLE III.

	Red Spot.			Small Black Spots.						Oblong Spot.	White Spot.
	P	M	F	1	2	3	4	5	6		
1890.	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
April 26	15 49·3	16 0·7	16 23·2	15 53·2							
July 8	...	11 16·3	11 38·3	...	11 20·3						
13	...	...	...	...	...	11 55·5					
14	...	...	...	...	...	...	12 30·4				
15	...	12 9·5	12 29·5	...	12 13·0	13 37·3					
30	...	9 22·9	9 48 8	...	9 35·8	10 48·6	...	...	...	...	10 11·2
Aug. 1	10 36·6	11 1·0	11 23·4	10 17·6	11 3·0	...	...	...	...	...	11 47·9
2	...	...	...	...	...	9 42·9					
6	...	...	...	...	...	11 30·6	...	...	...	...	10 59·2
8	...	...	...	11 3·8							
11	...	...	...	8 32·4	...	...	...	...	...	...	9 58·0
13	...	11 ·5	...	...	11 1·0						
17	...	...	...	...	...	...	...	...	1 29·0		
18	9 37·9	10 2·4	10 25·3	...	10 0·9	...	...	...	...	...	10 32·3
21	...	...	...	...	...	8 43·2					
25	...	10 40·5	...	9 58·0	10 39·5						
26	...	...	...	...	...	7 52·1	9 37				

	Red Spot.			Small Black Spots.						Oblong Spot.	White Spot.
	P	M	F	1	2	3	4	5	6		
1890.	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
Aug. 28	7 52·0	8 10·4	...	...	8 8·9						
Sept. 1	...	...	...	...	...	...	7 35·3				
2	...	7 26·3	...	...	7 18·0						
5	...	...	...	...	...	...	7 39·7				
9	...	8 6·7	...	7 19·9							
11	...	...	...	...	...	10 57	...	7 6·5			
14	6 55·5	±7 17·4	7 42·3	...	7 5·5						
21	...	8 10·1	8 35·0	7 17·2	7 51·1						
Oct. 12	...	...	...	...	10 5·3	...	...	...	...	...	10 5·
20	...	7 8·6	...	...	6 45·2						
26	...	...	...	...	...	...	7 54·6				
27	7 33·8	7 56·6	...	6 50·9	7 33·8						
28	...	...	...	...	...	...	6 16·0				
29	...	...	...	8 31·0	...	...	6 47·0	...	..	6 53·4	
Nov. 20	...	...	...	6 41·3							
1891.											
June 5	...	16 27·3									
July 4	...	...	...	12 33							

Longitudes of Spots, Referred to Marth's System II.

TABLE IV.

Date. 1890.	Red Spot. P	Red Spot. M	Red Spot. F	Small Black Spots. 1	2	3	4	5		Oblong Spot.	White Spot.
	°	°	°	°	°	°	°	°	°	°	°
April 26	346·0	352·9	6·5	348·4							
July 8	...	355·5	8·8	...	257·9						
13	...	...	...	...	...	51·2					
14	...	...	...	...	...	...	...	222·9			
15	...	360·5	12·6	...	364·7	53·6					
30	...	355·9	11·5	...	363·7	47·7	...	...	...	...	25·1
Aug. 1	341·3	356·0	9·5	329·8	357·2	...	...	...	...	...	24·2
2	...	...	...	...	...	...	...	...	260·9		
6	...	...	...	...	...	45·8	...	...	...	...	26·9
8	...	...	...	330·5							
11	...	...	...	330·0	...	...	...	...	...	...	21·7
13	...	361·5	...	...	360·6						
17	...	...	...	...	...	...	...	...	359·1		
18	342·2	357·0	10·7	...	356·1	...	...	...	...	...	15·0
21	...	...	...	...	...	40·0					
25	...	352·3	...	326·7	351·7						
26	...	...	...	...	...	40·8	104·2				
28	341·5	352·6	...	...	351·6						

Date.	Red Spot. P	Red Spot. M	Red Spot. F	Small Black Spots. 1	Small Black Spots. 2	Small Black Spots. 3	Small Black Spots. 4			Oblong Spot.	White Spot.
1890.	°	°	°	°	°	°	°	°	°	°	°
Sept. 1	...	...	...	...	...	...	...	212·7			
2	...	357·4	...	...	352·4						
5	...	...	...	...	...	...	96·3				
9	...	353·9	...	325·6							
11	...	...	...	...	...	37·3	...	...	258·0		
14	342·0	355·2	10·3	...	348·0						
21	...	358·8	13·7	326·8	347·4						
Oct. 12	...	356·5	...	...	342·2	...	...	...	...	...	342·2
20	...	356·5	...	...	342·3						
26	...	...	...	...	...	...	...	205·0			
27	342·4	356·2	...	316·5	342·4						
28	...	...	...	...	...	...	85·4				
29	...	...	...	317·4	...	...	...	...	354·4	258·3	
Nov. 20	...	...	...	314·5							
23	...	357·8									
1891.											
June 5	...	3·1									
July 4	...	...	...	260·1							

Oct. 12. Perhaps the white spot observed is not the one previously noted. The transit refers to a white spot on the parallel of the one observed before. It was on the same meridian with spot 2.

Note on the First Satellite of Jupiter. By E. E. Barnard, M.A.

In reference to my previous remarks on the apparent duplicity of this satellite, I would state that it now transits in front of the dark south equatorial belt, and therefore does not appear dark in transit, being very nearly the same depth of shade as the belt when in mid-transit. Before these dark transits can again be observed the satellite's apparent latitude must increase considerably to shift it on to the bright surface of the planet south of the equatorial belt. This will not occur before the opposition of 1892.

I have been carefully watching the satellite, however, with the 12-in. when in transit as a bright spot, before it reaches the point of disappearance.

On August 3 I examined it thus, with the 36-inch refractor, when it appeared as an elongated white spot, the preceding end of which was the smaller. Under the best definition, with 700 diameters, this elongation was decidedly noticeable, and in moments of extra definition I suspected a line of separation; but this I could not be sure of. If the satellite actually consisted of two bodies the distance between their centres could scarcely have exceeded $0''.2$.

The angle of position was estimated to be $265° \pm$ referred to the following end.

"At $13^h\ 0^m$ (Mt. H. M.T.) Satellite I. is surely much elongated—nearly parallel to the belts. Its shadow is large and round."

"$13^h\ 17^m$. There is no hesitation as to I. being elongated. Occasionally I think there are two; if so, the smaller one is preceding."

Shortly after this the satellite was lost or only faintly visible. Expecting to be able to catch it when leaving the disc, I turned to the east and observed Encke's Comet. Before the dome could be again turned to the south the satellite had just emerged. The definition then was not such as to give any information as to the form of the disc.

Satellite II. was carefully watched as it transited, preceding I. It appeared perfectly round until it wholly disappeared on the belt. *This was during the time that I. appeared elongated.*

Mount Hamilton:
1891 *August* 4.

On the Phenomena of the Transits of the First Satellite of Jupiter.

By E. E. Barnard.

The elongation of the disc of the first satellite at its transit on August 3, this year, recalls the first theory which I have previously offered in explanation of the apparent duplicity of that satellite at its transit on September 8, 1890.

On August 3 the angle of elongation was about 90° different from that of September 8, and the satellite appeared white in front of a dark belt.

The phenomena of both transits might now be quite satisfactorily explained by the assumption of a white belt on the satellite nearly parallel to the belts of *Jupiter*. To illustrate my idea I have prepared the drawing (Plate 14, fig. 5), which shows the appearance of the satellite on the two dates mentioned, side by side with the possible explanation. The left-hand figure of the upper drawing shows the satellite in double transit on the bright equatorial belt of *Jupiter*, September 8, 1890. The left-hand figure in the lower drawing shows the same object passing before the dark equatorial belt as an elongated white spot, on August 3, 1891.

In the first case, if a bright belt existed on the satellite, it would have the effect of apparently cutting it into two parts, since the belt would be lost in the bright surface of *Jupiter*. The satellite would, therefore, appear as two dusky dots, which, through irradiation, would appear small and round. The upper drawing explains this. In the second case—August 3—the satellite being seen on a dark ground, its dark surface would be lost, and only the bright belt would be seen, the result being just the reverse of the first case. The lower drawing explains this. In other words, if there is a bright belt on I., that satellite will appear double when its transit occurs over a bright part of *Jupiter*, since the dark portions of its surface alone will be visible. When it transits before a dark belt it will appear elongated, the bright belt of the satellite alone being seen.

If the drawing is examined at a distance of six or eight feet, it will clearly illustrate these statements.

Whether the above is the true explanation of the observed phenomena or not must be decided by future observations. The only other alternative is that the satellite is double. In either case the observations certainly establish an important fact. Either the satellite has a bright belt on it similar and nearly parallel to those of *Jupiter*, and, reasoning from analogy, it rotates on an axis nearly perpendicular to the plane of its orbit, or it is actually double.

The true theory can be settled with absolute certainty by careful observations. If the phenomena are caused by a white belt, the satellite, when it transits a bright portion of *Jupiter*,

should always appear double, the apparent components nearly vertical to the belts of *Jupiter*; when it transits a dark belt it should always appear elongated in a line nearly parallel to the belts of *Jupiter*. If it is actually double the elongation or line of apparent duplicity should be seen under all angles.

In reference to the other satellites I have seen nothing to indicate a belt on either of them. I am certain there is nothing of the kind on the 3rd. Though I have often noticed an irregular dark marking on this satellite, I have seen nothing to indicate a belt.

Mount Hamilton:
1891 *August* 6.

Observations of the Solar Eclipse of 1891 *June* 6, *made at the Royal Observatory, Greenwich.*

(*Communicated by the Astronomer-Royal.*)

Observations of the Beginning of the Eclipse.

	G.M.T.				Instrument.	Aperture in ins.	Power.	Observer.
1891.	d	h	m	s				
June	6	5	2	29·3	S.E. Equat.	12·8	295	A.D.
		5	2	24·0	E. Equat.	6·7	220	L.
		5	2	11·7	Altaz.	4	100	A.C.
		5	2	36·0	Simms No. 1	4	75	S.D.

No observations of the end of the Eclipse were made, the Sun being hidden by clouds at the time.

The initials A. D., L., A. C., and S. D. are those of Mr. Downing, Mr. Lewis, Mr. Crommelin, and Mr. Dolman respectively.

During the progress of the Eclipse observations were made with the South-East Equatoreal, with the object of determining corrections to the Moon's tabular R.A. and N.P.D., and to the tabular semidiameters of the Sun and Moon.

The circumstances of this Eclipse were, however, not favourable for determination of corrections to the semidiameters.

The following measures were made by Mr. Downing, the declination microscopes being read by Mr. Thackeray:—

Putting—

$d\alpha$ = correction to Moon's R.A.

$d\delta$ = correction to Moon's N.P.D.

ds = correction to Moon's semidiameter

$d\mathrm{A}$ = correction to Sun's R.A.

$d\Delta$ = correction to Sun's N.P.D.

$d\mathrm{S}$ = correction to Sun's semidiameter

(1) From $5^h\ 14^m\ 24^s$ to $5^h\ 16^m\ 49^s$ G.M.T. 2 differences of N.P.D. of p and f cusps were observed, giving

$$+\tfrac{1}{4}d\alpha + d\delta + \tfrac{5}{4}d\mathrm{S} + \tfrac{5}{4}ds.$$

(2) From $5^h\ 19^m\ 44^s$ to $5^h\ 33^m\ 13^s$ G.M.T. 5 differences of R.A. of p and f cusps were observed, giving

$$+d\alpha + d\delta + 2d\mathrm{S} + 2ds.$$

(3) From $5^h\ 35^m\ 6^s$ to $5^h\ 42^m\ 40^s$ G.M.T. 7 differences of N.P.D. of south limbs of Sun and Moon were observed, giving

$$-d\delta + d\mathrm{S} - ds.$$

(4) From $6^h\ 1^m\ 35^s$ to $6^h\ 7^m\ 52^s$ G.M.T. 3 differences of R.A. of p and f cusps were observed, giving

$$-\tfrac{1}{2}d\alpha + \tfrac{3}{2}d\delta + 2d\mathrm{S} + 2ds.$$

Four resulting equations were found by taking the sums of the constituent equations in each group, obtained by a comparison of the measured with the tabular quantity as affected by the symbolical corrections $d\alpha - d\mathrm{A}$, $d\delta - d\Delta$, ds and $d\mathrm{S}$:—

$-13''.52 = +0.511\,(d\alpha - d\mathrm{A}) + 2.271\,(d\delta - d\Delta) + 2.446ds + 2.478d\mathrm{S}$			
$-31.24 = +4.743$	$+6.035$	$+9.137$	$+9.267$
$+13.77 =$	-7.000	-7.000	$+7.000$
$-32.98 = -2.017$	$+4.171$	$+5.555$	$+5.620$

the solution of which is

$$\begin{aligned} d\alpha - d\mathrm{A} &= +2''.306 \\ d\delta - d\Delta &= -5.204 \\ ds &= +1.043 \\ d\mathrm{S} &= -2.192 \end{aligned}$$

From observations of the Sun made on eight days between 1891 May 28 and June 13 :

$$d\mathrm{A} = -1''.50 \qquad d\Delta = -0''.33$$

Combining this result with that obtained from the equatorial observations during the eclipse, we obtain for the corrections to the tabular place of the Moon in R.A. and N.P.D. and to the tabular semidiameters of the Moon and Sun :—

$$\begin{aligned} d\alpha &= +0''.80 = +0^s.053 \\ d\delta &= -5.53 \\ ds &= +1.04 \\ d\mathrm{S} &= -2.19 \end{aligned}$$

From five transits of the Sun's diameter made on the afternoon of June 15, and ten measures of the diameter in N.P.D. made on the afternoon of June 17, with the same instrument and by the same observers, the apparent corrections to the tabular semidiameter of the Sun were found to be :—

$$\text{in R.A.} \quad = -0^{s}\cdot029 = -0''\cdot40$$
$$\text{in N.P.D.} = \qquad\qquad -1''\cdot01$$

The telescope of the south-east equatoreal has an aperture of 12·8 inches, and a magnifying power of 295 was used.

Advantage was also taken of the circumstance that both the following vertical and lower horizontal limbs of the Moon were in turn projected on the Sun to take an altazimuth observation in the ordinary way. A correction of $-3''$ was applied to the interpolated tabular semidiameter of the Moon, and the corrections to tabular R.A. and N.P.D. of the Moon were then deduced as $-0^{s}\cdot40$ and $-5''\cdot0$.

Applying the corrections to tabular places and semidiameters indicated by the south-east equatoreal observations, a computation was made of the time of geometrical first contact, which gave $5^{h}\ 2^{m}\ 4^{s}$ G.M.T., the N.A. time being $5^{h}\ 2^{m}\cdot2$.

The weather was very unfavourable during the eclipse. Most of the observations were made through cloud, and the cusps and limbs were sometimes very faint indeed and difficult to observe.

Royal Observatory, Greenwich:
1891 *August* 7.

Observations of the Transit of Mercury, 1891 *May* 10.
By W. J. Macdonnell.

I forward a few notes on the Transit of *Mercury* as observed here with a 6-inch Equatoreal Refractor, by Grubb, of Dublin. The geographical position of Port Macquarie is South Latitude 31° 27′, East Longitude $10^{h}\ 11^{m}\ 40^{s}\cdot41$ ($6^{m}\ 49^{s}\cdot60$ East of Sydney).

May 10 was a clear, bright day, but definition was disturbed, the Sun's limb boiling and very unsteady. The times were taken from a sidereal clock in local sidereal time, and reduced to Sydney Mean Time, the clock-error being found from star transits on the evening before and after the Transit of *Mercury*.

Ingress.

	h	m	s	
First Contact	9	59	30	Noted a little too late, perhaps about 20 seconds. ⊙'s limb very unsteady.
Second Contact	10	4	4	No black drop, but a hazy ligament formed; the time noted was the appearance of a light between *Mercury* and Sun.

Egress.

	h	m	s	
First Contact	2	50	16·5	Definition improved; time noted at first formation of ligament. Observation considered fair.
Last Contact	2	55	3·5	A little too soon, as both planet and Sun were unsteady.

No halo was seen round the planet, nor any light speck on its disc, although carefully searched for.

My telescope has a clear aperture of 6 inches, 97 inches focus. A Kellner eyepiece, power 70, was used for the contacts, and negative eyepieces of 110 and 200 for physical observations during the Transit. A solar diagonal and tinted wedge were used in conjunction with the eyepieces.

A few spots were observed on the Sun, forming a strong contrast with the intense blackness of *Mercury*. At intervals during the Transit the definition was good, *Mercury* bearing the power of 200 well, but no signs of an atmosphere were visible. I remember seeing a luminous halo round *Venus* during the Transit of December 1874, but nothing of the kind could be traced on this occasion.

Port Macquarie, New South Wales:
1891 *May* 14.

The Conjunction of Venus and Jupiter, 1891 April 7, observed at Windsor, New South Wales. By John Tebbutt.

Australia was well situated for the observation of the near approach of the planets *Venus* and *Jupiter* on April 7, 1891. Notwithstanding occasional clouds, I succeeded in obtaining twelve good measures of the differences of right ascension and of north polar distance with the filar micrometer of the 8-inch equatoreal. The steadiness and definition of the images were unusually satisfactory, and the individual measures very consistent. The following are the results, together with a comparison of them with those derived by interpolation with second differences from the *Nautical Almanac*. The correction for the defective illumination of *Jupiter's* western limb is insensible. The differential co-ordinates correspond to the mean of the twelve transits of *Jupiter's* centre over the single micrometer thread, which itself corresponds to $19^h\ 9^m\ 39^s{\cdot}9$ sidereal, or $18^h\ 6^m\ 27^s{\cdot}3$ mean time, at Windsor.

	h	m	s
Mean of sidereal times of transits of *Venus*' second limb ...	19	9	28·18
Sidereal time of semidiameter passing the meridian			−0·52
Concluded mean of sidereal times of transit of *Venus*' centre ...	19	9	27·66
Mean of sidereal times of transits of *Jupiter's* limbs	19	9	39·90
Difference of transits of centres. *Jupiter–Venus*			+12·24
Correction for error in perpendicularity of micrometer threads			− 0·10
Correction due to change of *Venus*' R.A.			− 0·04
Correction for differential refraction			− 0·02
Correction for differential parallax			+ 0·29
Concluded difference of geocentric apparent R.A. *Jupiter–Venus*			+12·37
Difference per *Nautical Almanac*			+12·22
Observation − Calculation ...			+ 0·15

	′	″
Observed difference of N.P.D. of north limb of planets... ...	+11	47·4
Correction for semidiameter of *Venus*		− 7·7
Correction for semidiameter of *Jupiter*		+16·1
Correction for change of *Venus*' N.P.D.		+ 0·2
Correction for differential refraction		+ 0·2
Correction for differential parallax		− 3·0
Concluded difference of geocentric apparent N.P.D. *Jupiter–Venus*	+11	53·2
Difference per *Nautical Almanac*	+11	54·1
Observation − Calculation ...		− 0·9

Windsor, New South Wales:
1891 *June* 1.

Ephemeris of the Satellite of Neptune, 1891–92. By A. Marth.

Greenwich, Noon.	P′	*a*	*b*	*u*−U	Diff.	U	B
1891.	°	″	″	°	°	°	°
Oct. 24	330·34	16·84	9·37	334·43	612·34	122·11	−33·81
Nov. 3	330·13	·89	9·38	226·77	·31	122·37	33·73
13	329·87	·93	9·38	119·08	·28	122·66	33·64
23	329·60	·95	9·37	11·36	·26	122·97	33·54
Dec. 3	329·32	·95	9·34	263·62	·26	123·28	33·44
13	329·05	·93	9·31	155·88	·26	123·59	33·34
23	328·80	·90	9·26	48·14	·28	123·88	33·24
1892.							
Jan. 2	328·57	16·85	9·21	300·42	612·32	124·14	−33·15
12	·38	·79	9·16	192 74	·36	·36	33·06
22	·23	·71	9·10	85·10	·41	·53	33·00
Feb. 1	328·13	·62	9·04	337·51	·46	·65	32·95
11	·08	·53	8·98	229·97	·52	·70	32·92
21	·09	·44	8·93	122·49	·59	·69	32·91
Mar. 2	328·15	·34	8·88	15·08	·65	·62	32·93
12	·26	·25	8·84	267·73	·71	·49	32·96
22	·43	·16	8·81	160·44	612·76	·30	33·01
Apr. 1	328·64	16·09	8·78	53·20		124·05	−33·07

The values of P′, *a*, *b*, and $u-\mathrm{U}$ are to be interpolated directly for the times for which the apparent positions of the satellite are required, and the position-angles p and distances s of the satellite are then found by means of the formulæ:

$$s \sin (\mathrm{P}'-p) = a \sin (u-\mathrm{U}),$$
$$s \cos (\mathrm{P}'-p) = b \cos (u-\mathrm{U}).$$

In the May number of the *Monthly Notices*, on page 439, Mr. Isaac Roberts has communicated position-angles of the satellite, which he has deduced from measurements of eight of his photographs of *Neptune*. The strict testing of these angles would require that either a good series of micrometrical measures made during the last opposition should be available or that the changes of the elements of the orbit should be better known than they are at present (cf. the remarks on pp. 459–460 of vol. 49). But though, on account of the existing uncertainty of the shifting of the plane of the orbit, only approximate elements can be made use of, a comparison of the position-angles derived from the photographs with the corresponding computed places will not be without interest, as it sufficiently indicates the uncertainties pro-

duced by the difficulties of the measurements, which Mr. Roberts has mentioned. The following are the computed places of the satellite at the times corresponding to the beginning, middle, and ending of each exposure, as they are deduced from the elements adopted in the ephemeris published in vol. 50 :—

	Computed Dist.	Computed Posit.	Measured Posit.
1890. Dec. 9	16″·62	64°·21	
	16·78	62·10	59° 28′
	16·88	60·02	
12	16·82	241·14	
	16·83	240·97	232 10
	16·84	240·79	
1891. Jan. 10	14·10	260·27	
	14·25	259·27	261 46
	14·41	258·39	
Feb. 1	13·10	26·76	
	12·86	25·21	31 29
	12·62	23·61	
1891. Feb. 4	12″·70	204°·29	
	12·56	203·32	207° 6′
	12·42	202·33	
10	11·51	195·77	
	11·30	194·00	193 55
	11·09	192·16	
20	12·56	267·89	
	12·81	266·18	277 3
	13·06	264·54	
24	16·00	48·03	
	15·91	47·13	44 53
	15·82	46·23	

Ephemeris for Physical Observations of the Moon. By A. Marth.

1891 Nov. 9 to Dec. 25.

Greenwich, Noon.	Selenographical Colong. of the Sun.	Selenographical Lat. of the Sun.	Geocentric Libration. Sel. Long. of the Earth.	Geocentric Libration. Sel. Lat. of the Earth.	Geocentric Libration. Combined Amount.	Direction.
1891. Nov. 9	7°·15	+0°·28	−5°·30	+6°·76	8°·58	37°·9
10	19·32	·25	4·38	6·78	8·07	32·7
11	31·48	·22	3·17	6·38	7·12	26·3
12	43·63	·19	1·73	5·57	5·83	17·2
13	55·77	·16	−0·14	4·38	4·39	1·8
14	67 91	·13	+1·49	2·90	3·26	332·8
15	80·05	+0·10	+3·04	+1·23	3·28	292·1
16	92·18	·06	4·39	−0·51	4·42	263·4
17	104·32	+ ·03	5·46	2·18	5·88	248·2
18	116·46	·00	6·19	3·67	7·19	239·2
19	128·60	− ·03	6·51	4·92	8·15	232·8
20	140·74	·06	6·45	5·86	8·73	227·6
21	152·89	·09	6·03	6·49	8·85	222·7
22	165·05	−0·12	+5·29	−6·79	8·60	217·8
23	177·21	·15	4·30	6·78	8·02	212·2

Greenwich, Noon.	Selenographical Colong. of the Sun.	Lat. of the Sun.	Geocentric Libration. Sel. Long. of the Earth.	Lat. of the Earth.	Combined Amount.	Direction.
1891.	°	°	°	°	°	°
Nov. 24	189·38	−0·18	+3·12	−6·48	7·18	205·6
25	201·55	·21	1·82	5·89	6·17	197·1
26	213·73	·23	+0·49	5·06	5·09	185·6
27	225·92	·26	−0·81	−4·01	4·09	168·7
Dec. 7	347·80	−0·51	−3·47	+6·78	7·61	26·7
8	359·96	·54	2·59	6·48	6·98	21·7
9	12·11	·56	1·60	5·79	6·00	15·4
10	24·26	·59	−0·51	4·73	4·76	6·2
11	36·40	·62	+0·61	3·38	3·43	349·8
12	48·54	·65	1·75	1·81	2·52	316·1
13	60·67	−0·68	+2·82	+0·14	2·82	272·9
14	72·80	·71	3·77	−1·52	4·07	248·0
15	84·93	·74	4·55	3·07	5·49	235·9
16	97·05	·77	5·08	4·42	6·73	228·9
17	109·18	·80	5·34	5·48	7·65	224·1
18	121·31	·82	5·27	6·23	8·15	220·1
19	133·45	·85	4·88	6·64	8·24	216·2
20	145·59	−0·87	+4·19	−6·73	7·92	211·8
21	157·73	·90	3·23	6·51	7·26	206·3
22	169·88	·92	2·05	6·00	6·34	198·8
23	182·04	·94	+0·77	5·24	5·31	188·7
24	194·20	·96	−0·58	4·26	4·30	172·3
25	206·37	−0·98	−1·89	−3·10	3·63	148·7

Ephemerides of the Satellites of Saturn, 1891–92. By A. Marth.

Though the proper determination of the plane of *Saturn's* equator as the fundamental plane to which the orbits of the satellites are to be referred may have to be postponed till the results of the observations of 1892 shall have become available, the values of the nodes and inclinations of the orbits of Tethys, Rhea, and Enceladus, which Dr. Hermann Struve has deduced from his observations made during the four oppositions of 1886–89, and of which he has given some account in his papers published in Nos. 2945–46 and 2983–84 of the *Astronomische Nachrichten*, indicate the position of the planet's equator well enough to allow some fairly approximate assumption to be made, quite independently of any observations of the ring. The values of

the node and inclination of the fundamental plane adopted in the following ephemerides are, in reference to the planes parallel to the equator and the ecliptic,

	Equator. N.	Equator. J.	Ecliptic. Node.	Ecliptic. Inclin.	
1892·0	125°·9363	6°·9526	167°·0785	28°·0711	1°·1786
or 1891 Oct. 14	125·9278	6·9536	167·9755	28·0711	1·1789
92 Aug. 9	125·9603	6·9499	167·9870	28·0710	1·1778

The longitudes l, L, Λ of the ephemerides being referred to the equator, the angle 1°·1786 given in the last column must be subtracted, if they are to be referred to the ecliptic.

In the following tables P denotes the position-angle of the axis of *Saturn*, L+180° the planetocentric longitude of the Earth referred to the assumed fundamental plane, Λ+180° that of the Sun or Λ−L the difference between the two. B and B denote the planetocentric latitude of the Earth and Sun above the fundamental plane. The last column gives the longitude of *Saturn's* central meridian corrected for phase.

Greenwich Noon. 1891.	P	L	B	B	Λ−L	Long. of ♄ Central Merid.	Diff.
Oct. 14	355°·495	175°·592	+1°·217	−0°·217	−2°·313	39°·51	1687·45
16	·515	175·799	1·321	0·186	2·459	286·96	·46
18	·535	176·003	1·424	0·155	2·602	174·42	·46
20	·554	176·205	1·526	0·124	2·743	61·88	·47
22	·573	176·405	1·626	0·093	2·882	309·35	·47
24	355·592	176·603	+1·724	−0·063	−3·018	196·82	·48
26	·611	176·798	1·821	−0·032	3·152	84·30	·48
28	·630	176·990	1·916	−0·001	3·284	331·78	·49
30	·648	177·180	2·010	+0·029	3·412	219·27	·49
Nov. 1	·666	177·367	2·102	0·060	3·538	106·76	·50
3	355·684	177·550	+2·191	+0·091	−3·660	354·26	1687·51
5	·701	177·730	2·279	0·122	3·779	241·77	·52
7	·718	177·907	2·365	0·152	3·894	129·29	·52
9	·735	178·080	2·448	0·183	4·006	16·81	·52
11	·752	178 249	2·529	0·214	4·115	264·33	·53
13	355·768	178·415	+2·608	+0·244	−4·219	151·86	·54
15	·784	178·576	2·685	0·275	4·320	39·40	·54
17	·799	178·734	2·759	0·306	4·416	286·94	·55
19	·814	178·887	2·831	0·337	4·508	174·49	·56
21	·829	178·036	2·900	0·367	4·596	62·05	·56
23	355·843	179·180	+2·967	+0·398	−4·679	309·61	1687·57
25	·857	179·320	3·031	0·429	4·758	197·18	·58

Greenwich Noon.	P	L	B	*B*	A−L	Long. of ♄ Central Merid.	Diff.
1891.	°	°	°	°	°	°	°
Nov. 27	355·870	179·455	+3·092	+0·459	-4·832	84·76	1687·58
29	·883	179·585	3·151	0·490	4·901	332·34	·59
Dec. 1	·895	179·710	3·207	0·521	4·965	219·93	·59
3	355·907	179·830	+3·260	+0·551	−5·024	107·52	·60
5	·919	179·944	3·310	0·582	5·077	355·12	·61
7	·930	180·053	3·357	0·613	5·125	242·73	·61
9	·940	180·157	3·401	0·643	5·168	130·34	·62
11	·950	180·255	3·442	0·674	5·205	17·96	·62
13	355·959	180·347	+3·480	+0·705	−5·236	265·58	1687·63
15	·968	180·433	3·515	0·735	5·262	153·21	·64
17	·976	180·514	3·546	0·766	5·282	40·85	·64
19	·983	180·589	3·575	0·797	5·295	288·49	·65
21	·990	180·658	3·600	0·827	5·303	176·14	·66
23	355·996	180·720	+3·622	+0·858	−5·305	63·80	1687·66
25	356·002	180·776	3·640	0·888	5·300	311·46	·67
27	·007	180·826	3·655	0·919	5·287	199·13	·67
29	·011	180·870	3·667	0·950	5·272	86·80	·68
31	·015	180·907	3·676	0·980	5·248	334·48	·68
1892.							
Jan. 2	356·018	180·938	+3·681	+1·011	−5·218	222·16	1687·69
4	·020	180·962	3·683	1·041	5·181	109·85	·69
6	·022	180·980	3·681	1·072	5·138	357·54	·70
8	·023	180·991	3·676	1·102	5·088	245·24	·70
10	·023	180·995	3·668	1·133	5·032	132·94	·71
12	356·023	180·993	+3·656	+1·164	−4·969	20·65	·72
14	·022	180·985	3·641	1·194	4·900	268·37	·72
16	·021	180·970	3·623	1·225	4·825	156·09	·72
18	·019	180·949	3·602	1·255	4·743	43·81	·73
20	·016	180·922	3·577	1·286	4·655	291·54	·73
22	356·013	180·888	+3·549	+1·316	−4·560	179·27	1687·73
24	·009	180·848	3·518	1·347	4·459	67·00	·74
26	356·004	180·802	3·484	1·377	4·352	314·74	·74
28	355·999	180·750	3·447	1·408	4·239	202·48	·74
30	·993	180·691	3·407	1·438	4·120	90·22	·75
Feb. 1	355·986	180·627	+3·364	+1·469	−3·995	337·97	·75
3	·979	180·557	3·319	1·499	3·864	225·72	·75
5	·972	180·482	3·271	1·530	3·728	113·47	·76
7	·964	180·401	3·220	1·560	3·586	1·23	·76

Greenwich Noon.	P	L	B	*B*	A−L	Long. of ♄ Central Merid.	Diff.
1892.	°	°	°	°	°	°	°
Feb. 9	355·955	180·315	+3·167	+1·591	−3·440	248·99	1687·76
11	355·946	180·224	+3·111	+1·621	−3·288	136·75	1687·76
13	·936	180·128	3·053	1·652	3·132	24·51	·76
15	·926	180·028	2·993	1·682	2·971	272·27	·76
17	·916	179·924	2·931	1·713	2·805	160·03	·76
19	·905	179·815	2·867	1·743	2·636	47·79	·77
21	355·894	179 702	+2·801	+1·774	−2·462	295·56	·76
23	·882	179·585	2·734	1·804	2·284	183·32	·76
25	·870	179·465	2·665	1·834	2·103	71·08	·76
27	·858	179·341	2·595	1·865	1·919	318·84	·76
29	·845	179·215	2·524	1·895	1·732	206·60	1687·76
Mar. 2	388·832	179·086	+2·451	+1·926	−1·543	94·36	

The daily rate of rotation adopted in the computation of the Central Meridian is 843°·80, corresponding to a period of $10^h\ 14^m\cdot364$. It approximately represents the motion of the spots observed by Mr. A. Stanley Williams, the account of which is published in No. 3051 of the *Astron. Nachrichten.*

The values referring to the ball and ring depend on Bessel's old determinations. In the tables for the five inner satellites, *a* and *b* denote the semiaxes of the apparent orbits, *l*—L the orbital longitudes of the satellites reckoned from the points which are in superior conjunction with the planet's centre or in opposition to the Earth in longitude. By adding to *l*—L the value of L from the preceding table, the longitudes *l* are found, which are corrected for the equation of light.

Greenwich Noon.	Semidiameter of Ball. Equat.	Phase.	Polar.	Semiaxis of Ring. Major.	Minor.	*Mimas.* a_1	b_1	l_1-L	Diff.
1897.	″	″	″	″	″	″	″	°	°
Oct. 14	7·90	0·006	7·12	18·20	0·39	24·88	+0·53	125·42	763·83
16	7·91	·007	7·13	18·23	0·42	24·91	0·58	169·25	·84
18	7·92	·008	7·15	18·26	0·45	24·95	0·62	213·09	·84
20	7·93	·009	7·16	18 29	0·49	24·99	0·67	256·93	·84
22	7·95	·010	7·17	18·32	0·52	25·04	0·71	300·77	·85
24	7·96	·011	7·18	18·36	0·55	25·08	+0·76	344·62	·85
26	7·98	·012	7·20	18·39	0·58	25·13	0·80	28·47	·86
28	7·99	·013	7·21	18·43	0·62	25·18	0·85	72·33	·86
30	8·01	·014	7·23	18·47	0·65	25·23	0·89	116·19	·86
Nov. 1	8·03	·015	7·24	18·51	0·68	25·29	0·93	160·05	·87
3	8·05	·016	7·26	18·55	0·71	25·35	+0·97	203·92	763·88
5	8·07	·018	7·28	18·59	0·74	25·41	1·01	247·80	·88

Greenwich Noon.		Semidiameter of Ball. Equat.	Phase.	Polar.	Semiaxis of Ring. Major.	Minor.	*Mimas.* a_1	b_1	l_1-L	Diff.
1891.		″	″	″	″	″	″	″	°	°
Nov.	7	8·09	0·019	7·29	18·64	0·77	25·47	+1·05	291·68	763·89
	9	8·11	·020	7·31	18·68	0·80	25·53	1·09	335·57	·89
	11	8·13	·021	7·33	18·73	0·83	25·60	1·13	19·46	·90
	13	8·15	·022	7·35	18·78	0·86	25·66	+1·17	63·36	·90
	15	8·17	·023	7·37	18·83	0·88	25·73	1·21	107·26	·91
	17	8·19	·024	7·39	18·88	0·91	25·80	1·24	151·17	·91
	19	8·21	·025	7·41	18·94	0·94	25·88	1·28	195·08	·92
	21	8·24	·026	7·43	18·99	0·96	25·95	1·32	239·00	·92
	23	8·26	·027	7·46	19·05	0·99	26·03	+1·35	282·92	763·93
	25	8·29	·028	7·48	19·11	1·01	26·11	1·38	326·85	·93
	27	8·31	·029	7·50	19·17	1·03	26·19	1·41	10·78	·94
	29	8·34	·030	7·52	19·23	1·06	26·27	1·44	54·72	·95
Dec.	1	8·37	·031	7·55	19·29	1·08	26·36	1·47	98·67	·96
	3	8·39	·032	7·57	19·35	1·10	26·44	+1·50	142·63	·96
	5	8·42	·033	7·60	19·41	1·12	26·53	1·53	186·59	·96
	7	8·45	·034	7·62	19·48	1·14	26·62	1·56	230·55	·97
	9	8·48	·034	7·65	19·54	1·16	26·71	1·58	274·52	·98
	11	8·51	·035	7·68	19·61	1·18	26·80	1·61	318·50	·98
	13	8·54	·036	7·70	19·68	1·19	26·89	+1·63	2·48	763·99
	15	8·57	·036	7·73	19·75	1·21	26·98	1·65	46·47	764·00
	17	8·60	·037	7·76	19·81	1·23	27·08	1·67	90·47	·00
	19	8·63	·037	7·78	19·88	1·24	27·17	1·69	134·47	·01
	21	8·66	·037	7·81	19·95	1·25	27·27	1·71	178·48	·02
	23	8·69	·037	7·84	20·02	1·26	27·36	+1·73	222·50	·02
	25	8·72	·037	7·87	20·10	1·27	27·46	1·74	266·52	·03
	27	8·75	·037	7·89	20·17	1·28	27·56	1·76	310·55	·03
	29	8·78	·037	7·92	20·24	1·29	27·66	1·77	324·58	·04
	31	8·81	·037	7·95	20·31	1·30	27·76	1·78	38·62	·04
1892.										
Jan.	2	8·84	0·037	7·98	20·38	1·31	27·85	+1·79	82·66	764·05
	4	8·87	·036	8·01	20·45	1·31	27·95	1·80	126·71	·06
	6	8·90	·036	8·04	20·53	1·32	28·05	1·80	170·77	·06
	8	8·94	·035	8·06	20·60	1·32	28·15	1·80	214·83	·07
	10	8·97	·035	8·09	20·67	1·32	28·25	1·81	258·90	·08
	12	9·00	·034	8·12	20·74	1·32	28·35	+1·81	302·98	·08
	14	9·03	·033	8·15	20·81	1·32	28·44	1·81	347·06	·08
	16	9·06	·032	8·17	20·88	1·32	28·54	1·80	31·14	·09
	18	9·09	·031	8·20	20·95	1·32	28·63	1·80	75·23	·10

Greenwich Noon.	Semidiameter of Ball. Equat.	Phase.	Polar.	Semiaxis of Ring. Major.	Minor.	*Mimas.* a_1	b_1	l_1-L	Diff.
1892.	′	″	″	″	″	″	″	°	°
Jan. 20	9·12	0·030	8·23	21·02	1·31	28·72	+1·79	119·33	764·10
22	9·15	·029	8·25	21·09	1·31	28·81	+1·78	163·43	764·10
24	9·18	·028	8·28	21·15	1·30	28·90	1·77	207·53	·11
26	9·20	·027	8·31	21·22	1·29	28·99	1·76	251·64	·12
28	9·23	·025	8·33	21·28	1·28	29·08	1·75	295·76	·12
30	9·26	·024	8·35	21·34	1·27	29·16	1·73	339·88	·12
Feb. 1	9·29	·023	8·38	21·40	1·26	29·25	+1·72	24·00	·13
3	9 31	·021	8·40	21·46	1·24	29·33	1·70	68·13	·13
5	9·34	·020	8·42	21·52	1·23	29·41	1·68	112·26	·13
7	9·36	·018	8·44	21·57	1·21	29·48	1·66	156·39	·14
9	9·38	·017	8·46	21·63	1·20	29·55	1·63	200·53	·14
11	9·40	·015	8·48	21·68	1·18	29·62	+1·61	244 67	764·14
13	9·42	·014	8·50	21·73	1·16	29 69	1·58	288·81	·15
15	9·44	·013	8·52	21·77	1·14	29·75	1·55	332·96	·15
17	9·46	·011	8·54	21·82	1·12	29·81	1·52	17·11	·15
19	9·48	·010	8·56	21·86	1·09	29·87	1·49	61·26	·15
21	9·50	·009	8·57	21·90	1·07	29·92	+1·46	105·41	·15
23	9·51	·008	8·58	21·93	1·05	29·97	1·43	149·56	·15
25	9·53	·007	8·60	21·97	1·02	30·02	1·40	193·71	·15
27	9·54	·005	8·61	22·00	1·00	30·06	1·36	237·86	·16
29	9·55	·004	8·62	22·02	0·97	30·10	1·33	282·02	764·15
Mar. 2	9·56	0·003	8·63	22·05	0·94	30·13	+1·29	326·17	

Greenwich Noon.	*Enceladus.* a_2	b_2	l_2-L	Diff.	*Tethys.* a_3	b_3	l_3-L	Diff.
1891.	″	″	°	°	″	″	°	°
Oct. 14	31·91	+0·68	202·32	525·28	39·50	+0·84	119·289	381·205
16	31·96	0·74	7·60	·28	39·56	0·91	120·494	·208
18	32·01	0·80	172·88	·29	39·62	0·99	161·702	·212
20	32·06	0·86	338·17	·29	39·69	1·06	182·914	·215
22	32·12	0·91	143·46	·29	39·76	1·13	204·129	·218
24	32·18	+0·97	308·75	·30	39·83	+1·20	225·347	·221
26	32·24	1·02	114·05	·30	39·91	1·27	246·568	·225
28	32·30	1·08	279·35	·31	39·99	1·34	267·793	·229
30	32·37	1·14	84·66	·31	40·07	1·41	289·022	·233
Nov. 1	32·44	1·19	249·97	·32	40·16	1·47	310·255	·237
3	32·52	+1·24	55·29	525·32	40·25	+1·54	331·492	381·241
5	32·59	1·30	220·61	·32	40·34	1·60	352·733	·245
7	32·67	1·35	25·93	·33	40·44	1·67	13·978	·250

Greenwich Noon.	*Enceladus.* a_2	b_2	l_2-L	Diff.	*Tethys.* a_3	b_3	l_3-L	Diff.
1891.	"	"	°	°	"	"	°	°
Nov. 9	32·75	+ 1·40	291·26	525·33	40·54	+ 1·73	35·228	381·254
11	32·84	1·45	356·59	·34	40·65	1·79	56·482	·258
13	32 92	+ 1·50	161·93	·34	40·76	+ 1·85	77·740	·263
15	33·01	1·55	327·27	·35	40·87	1·91	99·003	·268
17	33·10	1·60	132·62	·35	40·98	1·97	120·271	·273
19	33·20	1·64	297·97	·36	41·10	2·03	141·544	·278
21	33·29	1·69	103·33	·36	41·22	2·09	162·822	·283
23	33·39	+ 1·73	268·69	525·37	41·34	+ 2·14	184·105	381·288
25	33·49	1·77	74·06	·38	41·46	2·19	205·393	·293
27	33·60	1·81	239·44	·38	41·59	2·24	226·686	·299
29	33·70	1·85	44·82	·39	41·72	2·29	247·985	·304
Dec. 1	33·81	1·89	210·21	·39	41·85	2·34	269·289	·310
3	33·92	+ 1·93	15·60	·39	41·99	+ 2·39	290·599	·315
5	34·03	1·97	180·99	·41	42·13	2·43	311·914	·321
7	34·14	2·00	346·40	·41	42·27	2·48	333·235	·328
9	34·26	2·03	151·81	·41	42·41	2·52	354·563	·333
11	34·38	2·06	317·22	·42	42·55	2·56	15·896	·338
13	34·50	+ 2·09	122·64	525·43	42·70	+ 2·59	37·234	381·345
15	34·62	2·12	288·07	·43	42·85	2·63	58·579	·351
17	34·74	2·15	93·50	·44	43·00	2·66	79·930	·357
19	34·86	2·18	258·94	·45	43·15	2·69	101·287	·362
21	34·98	2·20	64·39	·45	43·30	2·72	122·649	·369
23	35·10	+ 2·22	229·84	·46	43·45	+ 2·75	144·018	·376
25	35·23	2·24	35·30	·46	43·61	2·77	165·394	·381
27	35·35	2·26	200·76	·47	43·76	2·79	186·775	·388
29	35·48	2·27	6·23	·48	43·92	2·81	208·163	·394
31	35·61	2·28	171·71	·48	44·08	2·83	229·557	·400
1892.								
Jan. 2	35·73	+ 2·29	337·19	525·49	44·23	+ 2·84	250·957	381·406
4	35·86	2·30	142·68	·49	44·39	2·85	272·363	·413
6	35·98	2·31	308·17	·50	44·54	2·86	293·776	·419
8	36·11	2·31	113·67	·51	44·70	2·87	315·195	·425
10	36·24	2·32	279·18	·51	44·86	2·87	336·620	·431
12	36·36	+ 2·32	84·69	·52	45·01	+ 2·87	358·051	·437
14	36·48	2·32	250·21	·52	45·16	2·87	19·488	·443
16	36·61	2·31	55·73	·53	45·31	2 86	40·931	·449
18	36·73	2·31	221·26	·54	45·46	2·86	62·380	·454
20	36·85	2·30	26·80	·54	45·61	2·85	83·834	·460

Enceladus.

Greenwich Noon. 1892.	a_2	b_2	l_2-L	Diff.
	″	″	°	°
Jan. 22	36·96	+2·29	192·34	525·55
24	37·08	2·28	357·89	·55
26	37·19	2·26	163·44	·55
28	37·30	2·24	328·99	·56
30	37·41	2·22	134·55	·57
Feb. 1	37·52	+2·20	300·12	·57
3	37·62	2·18	105·69	·57
5	37·72	2·15	271·26	·58
7	37·82	2·12	76·84	·58
9	37·91	2·09	242·42	·59
11	38·00	+2·06	48·01	525·59
13	38·09	2·03	213·60	·59
15	38·17	1·99	19·19	·59
17	38·25	1·96	184·78	·60
19	38·32	1·92	350·38	·60
21	38·39	+1·88	155·98	·61
23	38·45	1·83	321·59	·60
25	38·51	1·79	127·19	·60
27	38·56	1·75	292·79	·61
29	38·61	1·70	98·40	525·61
Mar. 2	38·65	+1·65	264·01	

Tethys.

a_3	b_3	l_3-L	Diff.
″	″	°	°
45·76	+2·83	105·294	381·466
45·90	2·82	126·760	·471
46·04	2·80	148·231	·476
46·18	2·78	169·707	·482
46·31	2·75	191·189	·487
46·44	+2·73	212·676	·491
46·57	2·70	234·167	·496
46·70	2·67	255·663	·501
46·82	2·63	277·164	·504
46·93	2·59	298·668	·508
47·04	+2·55	320·176	381·512
47·15	2·51	341·688	·516
47·25	2·47	3·204	·519
47·34	2·42	24·723	·522
47·43	2·37	46·245	·525
47·52	+2·32	67·770	·527
47·60	2·27	89·297	·530
47·67	2·22	110·827	·531
47·74	2·16	132·358	·533
47·80	2·11	153·891	381·534
47·85	+2·05	175·425	

Dione.

Greenwich Noon. 1891.	a_4	b_4	l_4-L	Diff.
	″	″	°	°
Oct. 14	50·60	+1·07	324·467	262·875
16	50·67	1·17	227·342	·878
18	50·75	1·26	130·220	·880
20	50·83	1·35	33·100	·884
22	50·92	1·44	295·984	·886
24	51·02	+1·53	198·870	·890
26	51·12	1·62	101·760	·893
28	51·22	1·71	4·653	·896
30	51·33	1·80	267·549	·900
Nov. 1	51·44	1·89	170·449	·904
3	51·55	+1·97	73·353	262·908
5	51·67	2·05	336·261	·911
7	51·80	2·14	239·172	·916

Rhea.

a_5	b_5	l_5-L	Diff.
″	″	°	°
70·66	+1·50	251·945	159·181
70·76	1·63	51·126	·183
70·87	1·76	210·309	·186
70·99	1·89	9·495	·188
71·12	2·02	168·683	·191
71·25	+2·15	327·874	·194
71·38	2·27	127·068	·197
71·53	2·39	286·265	·200
71·68	2·51	85·465	·204
71·83	2·63	244·669	·208
71·99	+2·75	43·877	159·211
72·16	2·87	203·088	·214
72·34	2·98	2·302	·219

Greenwich Noon. 1891.		*Dione.* a_4	b_4	l_4-L	Diff.	*Rhea.* a_5	b_5	l_5-L	Diff.
		″	″	°	°	″	″	°	°
Nov.	9	51·93	+2·22	142·088	262·920	72·52	+3·10	161·521	159·222
	11	52·06	2·30	45·008	·924	72·70	3·21	320·743	·227
	13	52·20	+2·38	307·932	·929	72·89	+3·32	119·970	·231
	15	52·34	2·45	210·861	·934	73·09	3·42	279·201	·236
	17	52·49	2·53	113·795	·938	73·29	3·53	78·437	·240
	19	52·64	2·60	16·733	·943	73·50	3·63	237·677	·244
	21	52·79	2·67	279·676	·947	73·72	3·73	36·921	·249
	23	52·94	+2·74	182·623	262·953	73·94	+3·83	196·170	159·254
	25	53·10	2·81	85·576	·958	74·16	3·92	355·424	·259
	27	53·27	2·87	348·534	·963	74·39	4·01	154·683	·265
	29	53·44	2·94	251·497	·968	74·62	4·10	313·948	·269
Dec.	1	53·61	3·00	154·465	·974	74·86	4·19	113·217	·275
	3	53·78	+3·06	57·439	·980	75·10	+4·27	272·492	·280
	5	53·96	3·12	320·419	·985	75·35	4·35	71·772	·286
	7	54·14	3·17	223·404	·991	75·60	4·43	231·058	·292
	9	54·32	3·22	126·395	262·996	75·85	4·50	30 350	·297
	11	54·50	3·27	29·391	263·003	76·11	4·57	189·647	·303
	13	54·69	+3·32	292·394	·008	76·37	+4·64	348·950	159·308
	15	54·88	3·36	195·402	·014	76·64	4·70	148·258	·313
	17	55·07	3·40	98·416	·020	76·91	4·76	307·573	·320
	19	55·26	3·44	1·436	·027	77·18	4·81	106·893	·327
	21	55·46	3·48	264·463	·033	77·55	4·86	266·220	·333
	23	55·65	+3·51	167·496	·038	77·72	+4·91	65·553	·339
	25	55·85	3·54	70·534	·045	78·00	4·95	224·892	·346
	27	56·05	3·57	333·579	·051	78·27	4·99	24·238	·352
	29	56·25	3·60	236·630	·058	78·55	5·02	183·590	·358
	31	56·45	3·62	139·688	·064	78·83	5·05	342·948	·364
1892. Jan.	2	56·65	+3·64	42·752	263·070	79·11	+5 08	142·312	159·371
	4	56·85	3·65	305·822	·077	79·39	5·10	301·683	·377
	6	57·05	3·66	208·899	·083	79·67	5·12	101·060	·384
	8	57·25	3·67	111·982	·089	79 95	5·12	260·444	·390
	10	57·45	3·68	15·071	·095	80·23	5·13	59·834	·396
	12	57·65	+3·68	278·166	·102	80·81	+5·13	219·230	·403
	14	57·84	3·67	181·268	·107	80·78	5·13	18·633	·409
	16	58·04	3·67	84·375	·113	81·05	5·12	178·042	·414
	18	58·23	3·66	347·488	·120	81·31	5·11	337·456	·421
	20	58·42	3·65	250·608	·125	81·58	5·09	136·877	·427

Greenwich Noon. 1892.	*Dione.* a_4	b_4	l_4-L	Diff.	*Rhea.* a_5	b_5	l_5-L	Diff.
	″	″	°	°	″	″	°	°
Jan. 22	58·60	+3·63	153·733	263·131	81·84	+5·07	296·304	159·433
24	58·79	3·61	57·864	·137	82·10	5·04	95·737	·439
26	58·97	3·58	320·001	·142	82·35	5·00	255·176	·445
28	59·15	3·56	223·143	·148	82·60	4·96	54·621	·450
30	59·32	3·53	126·291	·153	82·84	4·92	214·071	·456
Feb. 1	59·49	+3·49	29·444	·158	83·07	+4·87	13·527	·461
3	59·65	3·45	292·602	·163	83·30	4·82	172·988	·466
5	59·81	3·41	195·765	·167	83·52	4·76	332·454	·471
7	59·96	3·37	98·932	·172	83·74	4·70	131·925	·476
9	60·11	3·32	2·104	·176	83·94	4·64	291·401	·480
11	60·25	+3·27	265·280	263·180	84·14	+4·57	90·881	159·485
13	60·39	3·22	168·460	·185	84·33	4·49	250·366	·489
15	60·52	3·16	71·645	·188	84·51	4·41	49·855	·493
17	60·64	3·10	335·833	·191	84·68	4·33	209·348	·497
19	60·75	3·04	238·024	·194	84·84	4·24	8·845	·500
21	60 86	+2·98	141·218	·197	84·99	+4·15	168·345	·503
23	60·96	2·91	44·415	·200	85·13	4·06	327·848	·506
25	61·05	2·84	307·615	·203	85·26	3·97	127·354	·509
27	61·14	2·77	210·818	·204	85·38	3·87	286·863	·512
29	61·21	2·70	114·022	263·206	85·48	3·77	86·375	159·513
Mar. 2	61·28	+2·62	17·228		85·58	+3·66	245·888	

The following are the approximate Greenwich times when the shadow of *Titan* crosses the central meridian, and when the satellite enters the shadow-cone of the planet. The times of some of the eclipses and shadow-transits of *Rhea* are also given, and it is very desirable that the latter should be carefully looked after, to ascertain whether the shadow cannot be discerned.

1891.	Gr. M. T.		1891.	Gr. M. T.	
Oct. 19	18·1	Tit. Shadow	Nov. 28	19·9	Tit. Ecl.
27	21·5	Tit. Ecl. Disapp.	Dec. 1	18·8	Rh. Sh.?
Nov. 4	16·0	Rhea Sh.?	3	22·9	Rh. Ecl.
—	17·3	Tit. Sh.	6	15·8	Tit. Sh.
6	20·2	Rh. Ecl.	10	19·7	Rh. Sh.?
12	20·7	Tit. Ecl.	12	23·8	Rh. Ecl.
13	17·0	Rh. Sh.?	14	19·1	Tit. Ecl.
15	21·1	Rh. Ecl.	19	20·6	Rh. Sh.?
20	16·6	Tit. Sh.	22	0·7	Rh. Ecl.
22	17·9	Rh. Sh.?	—	15·0	Tit. Sh.
24	22 0	Rh. Ecl.			

(*To be continued.*)

Col. Cooper's Observatory,
Markree, Collooney, Ireland.

Correction.

The values in the column "Corr. of log. Δ" in the Ephemeris for physical observations of *Jupiter*, p. 360 ff., are, owing to a mistake in transcribing the formula, considerably too large. The values should have been, at the beginning of June −34, and at the end of November and beginning of December +43, and as these values do not affect the apparent distance of the fourth satellite by more than 0·″006, the correction may be neglected. The heading β should have been B, and on p. 369, l. 13 and 14, 10^h should have been 9^h.

Erratum. By Harold Jacoby.

I desire to call attention to an error in my paper "On the Correction of Micrometric Measures for Refraction" (*Monthly Notices*, li. 2, p. 79). In the expression for $r-r'$ I should have used $(\zeta-\zeta')^3$, not $(\zeta-\zeta')^2$. The effect of this upon the result will be very small; and in the tables issued at the Royal Observatory, Cape Town, it may be entirely corrected by multiplying every number in Table I. β by $\frac{\cos(\pi-q)}{7\cdot2}$, and afterwards multiplying the quantity taken from the table by σ^3, not σ^2. The correction $\beta\sigma^3$ will then always be positive.

Columbia College, New York:
1891 *August* 6.

Errata in Mr. Christie's paper, On a New Dome to be erected at the Royal Observatory, Greenwich, vol. li., *no.* 7.

Page 436, line 18, *for* diameter *read* radius.
„ „ 20, *for* 13 feet 3 inches *read* 17 feet 3 inches.

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